

## ABSTRACT

A scheme for guaranteeing network tunnel path (NTP), e.g., Internet Protocol (IP), service levels in optical (e.g., wavelength-division multiplex (WDM)) networks. The invention, in one embodiment, accounts for both network topology (e.g., switches, cross-connects, and links between nodes) and resource usage (e.g., available/provisioned link bandwidth and available/used wavelength paths), which information may be available from the IP and optical WDM protocol layers, in particular (i) router capacities and (ii) presence or absence of wavelength conversion capability of optical cross-connect at each node. A determination is made whether to route an arriving request for an NTP over existing topology by computing "good" routes in accordance with a defined metric, or to open a new, available optical wavelength path by provisioning nodes of the topology for, and computing "good" routes for new wavelength paths. As many requests as possible are identified without *a priori* information of future requests.

A network employs integrated, dynamic routing (IDR) of service level (e.g., bandwidth) guaranteed paths for network tunnel paths (NTPs), such as Internet Protocol (IP) packet connections, through an optical network, such as a wavelength-division multiplex (WDM) optical network. For example, IDR accounts for both optical network topology (e.g., optical switches and crosseconnects as well as the links between nodes) and resource usage information (e.g., the available/provisioned link bandwidth and available/used wavelength paths). The topology and usage information may be available from the IP and optical WDM protocol layers. IDR determines several aspects of routing for an arriving request for a network tunnel path (e.g., a request to set up a new packet connection). First, IDR determines whether to route an arriving request for a network tunnel path over the existing topology or to open a new, available optical wavelength paths. Second, if IDR determines to route the request over the existing topology, "good" routes in accordance with a defined metric are computed. Third, if new wavelength paths are opened, IDR identifies which nodes (e.g., optical switches or routers) of the topology are to be provisioned for the new wavelength path and computes "good" routes for these new wavelength paths. IDR accommodates as many requests as possible without a priori information of future requests. IDR accounts for i) router capacities, and ii) presence or absence of wavelength conversion capability of optical crosseconnect at each node.